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Publications and Services of the National Bureau of Standards Cryogenics Division Institute for Basic Standards Boulder, Colorado 80302 1953 - 1972

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NATIONAL BUREAU OF STANDARDS

The National Bureau of Standards¹ was established by an act of Congress March 3, 1901. The Bureau's overall goal is to strengthen and advance the Nation's science and technology and facilitate their effective application for public benefit. To this end, the Bureau conducts research and provides: (1) a basis for the Nation's physical measurement system, (2) scientific and technological services for industry and government, (3) a technical basis for equity in trade, and (4) technical services to promote public safety. The Bureau consists of the Institute for Basic Standards, the Institute for Materials Research, the Institute for Applied Technology, the Institute for Computer Sciences and Technology, and the Office for Information Programs.

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Applied Mathematics — Electricity — Mechanics — Heat — Optical Physics — Nuclear Sciences² — Applied Radiation² — Quantum Electronics³ — Electromagnetics³ — Time and Frequency³ — Laboratory Astrophysics³ — Cryogenics³.

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THE OFFICE FOR INFORMATION PROGRAMS promotes optimum dissemination and accessibility of scientific information generated within NBS and other agencies of the Federal Government; promotes the development of the National Standard Reference Data System and a system of information analysis centers dealing with the broader aspects of the National Measurement System; provides appropriate services to ensure that the NBS staff has optimum accessibility to the scientific information of the world. The Office consists of the following organizational units:

Office of Standard Reference Data — Office of Technical Information and Publications — Library — Office of International Relations.

¹ Headquarters and Laboratories at Gaithersburg, Maryland, unless otherwise noted; mailing address Washington, D.C. 20234.

² Part of the Center for Radiation Research.

³ Located at Boulder, Colorado 80302.

⁴ Part of the Center for Building Technology.

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**Publications and Services
of the National Bureau of Standards
Cryogenics Division
Institute for Basic Standards
Boulder, Colorado 80302
1953 - 1972**

J. R. Mendenhall, V. J. Johnson, and N. A. Olien

**Cryogenics Division
Institute for basic Standards
National Bureau of Standards
Boulder, Colorado 80302**



**U.S. DEPARTMENT OF COMMERCE, Frederick B. Dent, Secretary
NATIONAL BUREAU OF STANDARDS, Richard W. Roberts, Director**

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**NATIONAL BUREAU OF STANDARDS
CRYogenics DIVISION
INSTITUTE FOR BASIC STANDARDS
Boulder, Colorado 80302**

CRYOGENICS DIVISION (275.00)

Determines low temperature properties of solids, fluids, and systems; performs research in cryogenic metrology and fluid transport processes; investigates basic problems and phenomena associated with cryogenic technology; provides consulting service to Government agencies; makes technical information available to the public.

CRYOGENIC TECHNICAL SERVICES SECTION (275.01)

Provides technical services to the Division in support of research programs consisting of engineering design of cryogenic apparatus; fabricates and installs experimental equipment; assists in the operation of experimental test facilities; acquires and maintains supplies and laboratory instruments; operates unique process facilities for research and testing; and procures and distributes liquefied and purified gases.

CRYOGENIC DATA CENTER SECTION (275.02)

Critically evaluates and compiles data on the thermophysical properties of cryogenic fluids, metals, alloys, and dielectrics; operates an automated bibliographic service, including the acquisition, cataloging, coding, storing, and retrieval of pertinent literature; monitors current literature in cryogenics; and furnishes through listings of selected items a current awareness service to the cryogenic community.

CRYOGENIC PROPERTIES OF SOLIDS SECTION (275.03)

Performs basic and applied research on the physical, transport, mechanical, and metallurgical properties of solids, primarily metals. Places special emphasis on the development of accurate and advanced measurement technology, on the generation of standard reference data, and on the development and characterization of standard reference materials.

PROPERTIES OF CRYOGENIC FLUIDS SECTION (275.04)

Measures, computes, and correlates the thermodynamic, electromagnetic, and transport properties of cryogenic fluids throughout a wide range of temperatures and densities; and measures the phase equilibrium properties and excess thermodynamic functions of mixtures of simple dense fluids.

CRYOGENIC SYSTEMS SECTION (275.05)

Measures, analyzes, and correlates the properties of cryogenic systems; investigates basic problems and phenomena associated with cryogenic engineering technology to explain and predict the behavior of cryogenic systems; consults and provides advisory services for other Bureau programs, other Government agencies, and the public; and promotes and establishes cryogenic standard practices.

CRYOGENIC METROLOGY SECTION (275.06)

Investigates fundamental principles of cryogenic measurements; performs research on the basic phenomena that may be applied to cryogenic instruments; studies those properties of materials, matter-matter and matter-energy interactions which could lead to new measurement principles; develops improved cryogenic measurement devices and methodology; evaluates transducers; investigates and recommends application techniques; and consults and provides advisory services for other NBS programs, other Government agencies, and the public.

CRYOELECTRONICS SECTION (275.08)

Investigates the applications of superconductivity and other low temperature phenomena to improve techniques and instruments for making measurements of electrical quantities, including fundamental constants. Demonstrates the feasibility and limitations of radically new instruments. Provides assistance, especially to other NBS divisions, in adapting this new technology to the establishment of standards and measurement science. Performs background research necessary to support these functions.

Contents

	Page
Introduction	vii
List of Publications	1
Miscellaneous Reports	43
Thermodynamic Properties Charts	47
Author Index	53
Subject Index	63
Index - NBS Technical Notes, NBS Monographs, NBS Special Publications, NBS Circulars, etc.	67
Bibliographies	71
Cryogenic Data Center Services	73
Other Services	75

Publications and Services of the National Bureau of Standards
Cryogenics Division, Institute for Basic Standards
Boulder, Colorado 80302
1953 - 1972

J. R. Mendenhall, V. J. Johnson, and N. A. Olien

This NBS Technical Note catalogs the publications of the Cryogenics Division, along with author and subject indexes, for the period 1953 through 1972. It also contains a listing of available thermodynamic properties charts, bibliographies, and miscellaneous reports of cryogenic interest.

A resume' of the activities of and services provided by the Cryogenics Division is also included.

Key words: Author indexes; bibliography; cryogenics; liquefaction; metrology; properties of fluids; properties of solids; subject indexes; superconductivity; transport processes.

Introduction

For a number of years the National Bureau of Standards - Cryogenic Data Center has furnished lists of publications resulting from the work of the NBS-Cryogenics Division. Supplements to these lists have been prepared and sent to persons engaged in cryogenic engineering and research. This Technical Note brings all of this information together in one publication and covers the entire period for which there are publications, 1953 through 1972. A number of indexes, including subject and author, have been included as well as information regarding other services of the Cryogenic Data Center.

Future supplements to this list of publications will be available to anyone asking to be placed on the mailing list. Request for inclusion on the mailing list should be directed to: National Bureau of Standards, Cryogenic Data Center, Boulder, Colorado 80302.

NATIONAL BUREAU OF STANDARDS
CRYOGENICS DIVISION
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List of Publications

NOTICE: Copies of these publications may be obtained as indicated by the superscripts at the end of each item. The superscripts refer to availability and are listed on page 4L.

- R-1 THE VAPOR PRESSURES OF THE DEUTEROMETHANES, by G. T. Armstrong, F. G. Brickwedde and R. B. Scott. J. Chem. Phys. Vol 21, No. 7, 1297-8 (Jul 1953). (PB172000)¹
- R-2 NBS-AEC CRYOGENIC ENGINEERING LABORATORY. Nat. Bur. Stand. (U.S.), Tech. News Bull. Vol 37, No. 10, 152-8 (Oct 1953). (PB172001)¹
- R-3 LOW-TEMPERATURE LIQUID-LEVEL INDICATOR FOR CONDENSED GASES. Nat. Bur. Stand. (U.S.), Tech. News Bull. Vol 38, No. 1, 3-4 (Jan 1954). (PB172002)¹
- R-4 LIQUID LEVEL INDICATOR FOR CONDENSED GASES AT LOW TEMPERATURES, by W. E. Williams and E. Maxwell. Rev. Sci. Instrum. Vol 25, No. 2, 111-4 (Feb 1954). (PB172003)¹
- R-5 THERMAL CONDUCTIVITY OF METALS AND ALLOYS AT LOW TEMPERATURES, by R. L. Powell and W. A. Blanpied. Nat. Bur. Stand. (U.S.), Circ. No. 556 68 pages (Sep 1954). (PB172004)²
- R-6 ADVANCES IN CRYOGENIC ENGINEERING (Proc. 1954 Cryogenic Engineering Conf., Sept. 8-10, Boulder, Colorado; K. D. Timmerhaus, Editor) Vol 1. Plenum Press, New York (1960). (Plenum Press, New York - \$25.00)⁴
- R-7 A FEW REMARKS ON THE BEGINNINGS OF THE NBS-AEC CRYOGENIC ENGINEERING LABORATORY, by F. G. Brickwedde. Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 1-4. Plenum Press, New York (1960). (PB172005)¹
- R-8 EXPERIMENTAL DEWARs DEVELOPED BY THE NATIONAL BUREAU OF STANDARDS, by B. W. Birmingham, E. H. Brown, C. R. Class and A. F. Schmidt. Paper B-1 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 49-61. Plenum Press, New York (1960). (PB172006)¹
- R-9 A RE-LIQUEFYING HYDROGEN REFRIGERATOR, by G. E. McIntosh, D. Mann, J. Macinko and P. C. Vander Arend. Paper B-2 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 62-76. Plenum Press, New York (1960). (PB172007)¹
- R-10 JOINING ALUMINUM TO STAINLESS STEEL, by M. C. Smith and D. D. Rabb. Paper B-3 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 77-86. Plenum Press, New York (1960). (PB172008)¹
- R-11 THE TRANSFER OF LIQUEFIED GASES, by R. B. Jacobs, R. J. Richards and S. B. Schwartz. Paper B-4 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 87-94. Plenum Press, New York (1960). (PB172009)¹
- R-12 A TRANSFER LINE FOR LIQUEFIED GASES, by K. B. Martin and O. E. Park. Paper B-5 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 95-104. Plenum Press, New York (1960). (PB172010)¹
- R-13 PERFORMANCE OF AN AIR EXPANSION ENGINE, by J. E. Jensen. Paper B-6 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 105-10. Plenum Press, New York (1960). (PB172011)¹
- R-14 A HIGH-VACUUM SEAL-OFF VALVE, by R. J. Richards. (a) Paper B-7 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 111-3. Plenum Press, New York (1960). (Out of print). (b) Rev. Sci. Instrum. Vol 25, 520-1 (May 1954). (PB172012)¹
- R-15 CONTINUOUS ANALYSIS OF ORTHO-PARAHYDROGEN MIXTURES, by D. H. Weitzel and R. L. Hershey. Paper C-2 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 122-5. Plenum Press, New York (1960). (PB172013)¹
- R-16 A HYDROGEN GAS METER UNIT WITH REMOTE TOTALIZATION OF FLOW, by R. H. Kroppschot. Paper C-4 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 131-7. Plenum Press, New York (1960). (PB172014)¹

- R-17 PULSATION DAMPING, by C. R. Myer. Paper C-5 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 138-43. Plenum Press, New York (1960). (PB172015)¹
- R-18 THERMISTOR INDICATING FLOWMETER FOR LOW RATES OF NITROGEN AND HYDROGEN GASES, by J. W. Allen, M. M. Fulk and M. M. Reynolds. Paper D-1 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 151-3. Plenum Press, New York (1960). (PB172016)¹
- R-19 A SENSITIVE ELECTRONIC LIQUID LEVEL INDICATOR FOR CONDENSED GASES, by D. W. Braudway, S. B. Schwartz and J. W. Allen. Paper D-2 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 154-5. Plenum Press, New York (1960). (PB172017)¹
- R-20 LOW TEMPERATURE ELECTRICAL RESISTANCE OF FIFTEEN COMMERCIAL CONDUCTORS, by O. E. Park, M. M. Fulk and M. M. Reynolds. Paper D-3 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 156-7. Plenum Press, New York (1960). (PB172018)¹
- R-21 CARBON RESISTORS AND VARIABLE DIFFERENTIAL TRANSFORMERS FOR LIQUID LEVEL INDICATION, by S. B. Schwartz and A. E. Wilson. Paper D-4 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 158-61. Plenum Press, New York (1960). (PB172019)¹
- R-22 MODIFICATION OF A CALORIMETRIC OXYGEN DETECTOR FOR USE WITH NON-EQUILIBRIUM HYDROGEN, by A. E. Wilson, S. B. Schwartz and R. J. Corruccini. Paper D-6 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 164-7. Plenum Press, New York (1960). (PB172020)¹
- R-23 TRACE OXYGEN ANALYSIS FOR LIQUID HYDROGEN PRODUCTION, by E. Catalano. Paper D-8 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 169-70. Plenum Press, New York (1960). (PB172021)¹
- R-24 VACUUM POWDER INSULATION, by M. M. Reynolds, J. D. Brown, M. M. Fulk, O. E. Park and G. W. Curtis. Paper F-2 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 216-23. Plenum Press, New York (1960). (PB172022)¹
- R-25 THERMAL RADIATION ABSORPTION BY METALS, by M. M. Fulk, M. M. Reynolds and O. E. Park. Paper F-3 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 224-9. Plenum Press, New York (1960). (PB172023)¹
- R-26 THE MECHANICAL PROPERTIES TESTING PROGRAM AT THE NBS-AEC CRYOGENIC ENGINEERING LABORATORY, by R. H. Kropschot. Paper G-1 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 235-41. Plenum Press, New York (1960). (PB172024)¹
- R-27 THERMAL CONDUCTIVITY OF SOLIDS AT LOW TEMPERATURES, by R. L. Powell and D. O. Coffin. Paper G-5 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 262-6. Plenum Press, New York (1960). (PB172025)¹
- R-28 ORTHO-PARAHYDROGEN CONVERSION STUDIES, by P. L. Barrick, D. H. Weitzel and T. W. Connolly. Paper H-4 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 285-90. Plenum Press, New York (1960). (PB172026)¹
- R-29 VIBRATION TESTING OF AIRBORNE CRYOGENIC EQUIPMENT, by P. R. Weaver, W. E. Smull and E. H. Brown. Paper H-6 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 296-301. Plenum Press, New York (1960). (PB172027)¹
- R-30 PERFORMANCE OF NBS HYDROGEN LIQUEFIER PLANT, by V. J. Johnson and W. A. Wilson. Paper J-4 in Advances in Cryogenic Engineering (Proc. 1954 Cryogenic Engineering Conf.) Vol 1, 329-35. Plenum Press, New York (1960). (PB172028)¹
- R-31 CONTINUOUS ANALYSIS OF ORTHOPARAHYDROGEN MIXTURES, by D. H. Weitzel and L. E. White. Rev. Sci. Instrum. Vol 26, No. 3, 290-2 (Mar 1955). (PB172029)¹
- R-32 LOW-TEMPERATURE THERMAL CONDUCTIVITY OF A FREE-MACHINING COPPER, by R. L. Powell and D. O. Coffin. Rev. Sci. Instrum. Vol 26, No. 5, 516 (May 1955). (PB172030)¹
- R-33 VALVE FOR COLD FLUIDS, by R. J. Richards and R. B. Jacobs. Rev. Sci. Instrum. Vol 26, No. 7, 730 (Jul 1955). (PB172031)¹
- R-34 VAPOR PRESSURES OF THE METHANES, by G. T. Armstrong, F. G. Brickwedde and R. B. Scott. J. Res. Nat. Bur. Stand. (U.S.), Vol 55, No. 1, 39-52 (Jul 1955). (PB172032)¹

- R-35 ACTIVITIES OF THE NATIONAL BUREAU OF STANDARDS CRYOGENIC ENGINEERING LABORATORY, by R. B. Scott. In Conference de Physique des Basses Temperatures (Paris, France, Sept. 2-8, 1955) Communication, 368-71. (PB172033)¹
- R-36 SOME ASPECTS OF THE LARGE SCALE LIQUEFACTION OF HYDROGEN, by B. W. Birmingham. Paper 55-2-1 in Proc. Instrum. Soc. Amer. Vol 10, pt. 2, 1-4 (Sep 12-16, 1955). (PB172034)¹
- R-37 LOW TEMPERATURE SCALES FROM 90° to 5° K, by R. B. Scott. In Temperature, Its Measurement and Control in Science and Industry Vol 2, 179-84. Reinhold-Van Nostrand, New York (1955). (PB172035)¹
- R-38 IRON CATALYST FOR PRODUCTION OF LIQUID PARA-HYDROGEN, by D. H. Weitzel and O. E. Park. Rev. Sci. Instrum. Vol 27, No. 1, 57-8 (Jan 1956). (PB172036)¹
- R-39 CRYOGENIC ENGINEERING CONFERENCE. Nat. Bur. Stand. (U.S.), Tech. News Bull. Vol 40, No. 11, 165-6 (Nov 1956). (PB172037)¹
- R-40 HEAT CONDUCTION THROUGH INSULATING SUPPORTS IN VERY LOW TEMPERATURE EQUIPMENT, by R. P. Mikesell and R. B. Scott. J. Res. Nat. Bur. Stand. (U.S.), Vol 57, No. 6, 371-8 (Dec 1956). (PB172038)¹
- R-41 ADVANCES IN CRYOGENIC ENGINEERING (Proc. 1956 Cryogenic Engineering Conf., Sept. 5-7, Boulder, Colorado; K. D. Timmerhaus, Editor) Vol 2. Plenum Press, New York (1960). (Plenum Press, New York - \$25.00)⁴
- R-42 CATALYSIS OF THE ORTHO-PARAHYDROGEN CONVERSION, by D. H. Weitzel, J. W. Draper, O. E. Park, K. D. Timmerhaus and C. C. Van Valin. Paper A-3 in Advances in Cryogenic Engineering (Proc. 1956 Cryogenic Engineering Conf.) Vol 2, 12-8. Plenum Press, New York (1960). (PB172039)¹
- R-43 A NEW ARRANGEMENT FOR ORTHO-PARA CONVERSION OF LIQUID HYDROGEN IN THE LARGE CEL-NBS LIQUEFIER, by V. J. Johnson. Paper A-4 in Advances in Cryogenic Engineering (Proc. 1956 Cryogenic Engineering Conf.) Vol 2, 19-26. Plenum Press, New York (1960). (PB172040)¹
- R-44 DISTILLATION OF HYDROGEN-DEUTERIUM MIXTURES, by T. M. Flynn, D. H. Weitzel, K. D. Timmerhaus, P. C. Vander Arend and J. W. Draper. Paper A-6 in Advances in Cryogenic Engineering (Proc. 1956 Cryogenic Engineering Conf.) Vol 2, 39-44. Plenum Press, New York (1960). (PB172041)¹
- R-45 BREATHING OXYGEN STORAGE DEWARs, by W. A. Wilson. Paper B-1 in Advances in Cryogenic Engineering (Proc. 1956 Cryogenic Engineering Conf.) Vol 2, 54-8. Plenum Press, New York (1960). (PB172042)¹
- R-46 MECHANICAL PROPERTIES OF SOME ENGINEERING MATERIALS BETWEEN 20°K AND 300°K, by R. H. Kropschot, R. M. McClintock and D. A. Van Gundy. Paper C-2 in Advances in Cryogenic Engineering (Proc. 1956 Cryogenic Engineering Conf.) Vol 2, 93-9. Plenum Press, New York (1960). (PB172043)¹
- R-47 AN EXPERIMENTAL STUDY OF THE STRENGTH AND FATIGUE OF GLASS AT VERY LOW TEMPERATURES, by R. H. Kropschot and R. P. Mikesell. Paper D-5 in Advances in Cryogenic Engineering (Proc. 1956 Cryogenic Engineering Conf.) Vol 2, 136-44. Plenum Press, New York (1960). (PB172044)¹
- R-48 CHARACTERISTICS OF SOME INSULATIONS FOR LIQUID OXYGEN TRANSFER LINES, by D. A. Van Gundy and R. B. Jacobs. Paper E-1 in Advances in Cryogenic Engineering (Proc. 1956 Cryogenic Engineering Conf.) Vol 2, 156-62. Plenum Press, New York (1960). (PB172045)¹
- R-49 HEAT TRANSFER THROUGH FOAMS AND POWDERS, by M. M. Fulk, R. J. Devereux and J. E. Schrodt. Paper E-2 in Advances in Cryogenic Engineering (Proc. 1956 Cryogenic Engineering Conf.) Vol 2, 163-5. Plenum Press, New York (1960). (PB172046)¹
- R-50 THERMAL CONDUCTIVITIES OF COPPER AND COPPER ALLOYS, by R. L. Powell, W. M. Rogers and H. M. Roder. Paper E-3 in Advances in Cryogenic Engineering (Proc. 1956 Cryogenic Engineering Conf.) Vol 2, 166-71. Plenum Press, New York (1960). (PB172047)¹
- R-51 CRYOGENIC CHARACTERISTICS OF WIRE RESISTANCE STRAIN GAGES, by R. M. McClintock. Paper E-4 in Advances in Cryogenic Engineering (Proc. 1956 Cryogenic Engineering Conf.) Vol 2, 172-6. Plenum Press, New York (1960). (PB172048)¹

- R-52 PERFORMANCE OF PUMPS WITH LIQUEFIED GASES, by K. B. Martin, R. B. Jacobs and R. J. Hardy. Paper G-6 in Advances in Cryogenic Engineering (Proc. 1956 Cryogenic Engineering Conf.) Vol 2, 295-302. Plenum Press, New York (1960). (PB172049)¹
- R-53 LONG DISTANCE TRANSFER OF LIQUEFIED GASES, by R. B. Jacobs. Paper G-7 in Advances in Cryogenic Engineering (Proc. 1956 Cryogenic Engineering Conf.) Vol 2, 303-17. Plenum Press, New York (1960). (PB172050)¹
- R-54 A LARGE LIQUID HYDROGEN BUBBLE CHAMBER, by D. B. Chelton, D. B. Mann and R. A. Byrns. Paper H-2 in Advances in Cryogenic Engineering (Proc. 1956 Cryogenic Engineering Conf.) Vol 2, 325-9. Plenum Press, New York (1960). (PB172051)¹
- R-55 VACUUM-INSULATED TRANSFER TUBE, by R. B. Jacobs and R. J. Richards. Rev. Sci. Instrum. Vol 28, No. 4, 291-2 (Apr 1957). (PB172052)¹
- R-56 STRENGTH AND FATIGUE OF GLASS AT VERY LOW TEMPERATURES, by R. H. Kropschot and R. P. Mikesell. J. Appl. Phys. Vol 28, No. 5, 610-4 (May 1957). (PB172053)¹
- R-57 VESSELS FOR STORAGE AND TRANSPORT OF LIQUID HYDROGEN, by B. W. Birmingham, E. H. Brown, C. R. Class and A. F. Schmidt. J. Res. Nat. Bur. Stand. (U.S.), Vol 58, No. 5, 243-53 (May 1957). (PB172054)¹
- R-58 POWDERS FOR LOW-TEMPERATURE INSULATION. Nat. Bur. Stand. (U.S.), Tech. News Bull. Vol 41, No. 6, 87 (Jun 1957). (PB172055)¹
- R-59 THERMAL DESIGN OF LARGE STORAGE VESSELS FOR LIQUID HYDROGEN AND HELIUM, by R. B. Scott. J. Res. Nat. Bur. Stand. (U.S.), Vol 58, No. 6, 317-25 (Jun 1957). (PB172056)¹
- R-60 DIRECT-COUPLED POWER AMPLIFIER FOR CRYOSTAT HEATING CONTROL, by R. D. Goodwin and J. R. Purcell. Rev. Sci. Instrum. Vol 28, No. 7, 581-2 (Jul 1957). (PB172057)¹
- R-61 A MECHANICAL REFRIGERATION PROCESS FOR THE NO-LOSS STORAGE OF LIQUID HYDROGEN, by B. W. Birmingham. Refrig. Eng. Vol 65, No. 7, 42-4 (Jul 1957). (PB172058)¹
- R-62 SINGLE-PHASE TRANSFER OF LIQUEFIED GASES, by R. B. Jacobs. Nat. Bur. Stand. (U.S.) Circ. No. 596, 42 pages (Aug 1957). (PB172059)²
- R-63 HYDROGEN LIQUEFACTION BY A DUAL PRESSURE PROCESS, by D. B. Chelton, J. Macinko and J. Dean. Refrig. Eng. Vol 65, No. 8, 39-41 (Aug 1957). (PB172060)¹
- R-64 PROPERTIES OF MATERIALS AT LOW TEMPERATURES, by R. J. Corruccini. Chem. Engr. Progr. Vol 53, Part 1, 262-7; Part 2, 342-6; Part 3, 397-402 (Jun, Jul, Aug 1957). (PB172061)¹
- R-65 LARGE BUBBLE CHAMBER. Nat. Bur. Stand. (U.S.), Tech. News Bull. Vol 41, No. 9, 129-30 (Sep 1957). (PB172062)¹
- R-66 CATALYST FOR PARAHYDROGEN PRODUCTION. Nat. Bur. Stand. (U.S.), Tech. News Bull. Vol 41, No. 10, 154-7 (Oct 1957). (PB172063)¹
- R-67 AN APPARATUS FOR MEASUREMENT OF THERMAL CONDUCTIVITY OF SOLIDS AT LOW TEMPERATURES, by R. L. Powell, W. M. Rogers and D. O. Coffin. J. Res. Nat. Bur. Stand. (U.S.), Vol 59, No. 5, 349-55 (Nov 1957). (PB172064)¹
- R-68 LOW-TEMPERATURE THERMAL CONDUCTIVITY OF SOME COMMERCIAL COPPERS, by R. L. Powell, H. M. Roder and W. M. Rogers. J. Appl. Phys. Vol 28, No. 11, 1282-8 (Nov 1957). (PB172065)¹
- R-69 1957 CRYOGENIC ENGINEERING CONFERENCE, Nat. Bur. Stand. (U.S.), Tech. News Bull. Vol 41, No. 11, 177-8 (Nov 1957). (PB172066)¹
- R-70 EMISSIVITIES OF METALLIC SURFACES AT 76°K, by M. M. Fulk and M. M. Reynolds. J. Appl. Phys. Vol 28, No. 12, 1464-7 (Dec 1957). (PB172067)¹
- R-71 HELIUM LIQUEFACTION WITH THE LARGE HYDROGEN LIQUEFIER. Nat. Bur. Stand. (U.S.), Tech. News Bull. Vol 41, No. 12, 197 (Dec 1957). (PB172068)¹
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- MR-14b ELASTOMERIC SEALS AND MATERIALS AT CRYOGENIC TEMPERATURES, by D. H. Weitzel, R. F. Robbins, P. R. Ludtke and Y. Ohori. Wright Air Development Center, Wright-Patterson AFB, Materials Lab., Rept. No. ML-TDR-64-50 (Prepared at National Bureau of Standards, Boulder, Colo., Cryogenics Div., under Contr. No. AF 33(616)61-04), 141 pages (Mar 1964). Also National Bureau of Standards, Boulder, Colo., Cryogenics Div., Rept. -Unpublished. (AD460774)²
- MR-14c ELASTOMERIC SEALS AND MATERIALS AT CRYOGENIC TEMPERATURES, by D. H. Weitzel, R. F. Robbins and P. R. Ludtke. Wright Air Development Center, Wright-Patterson AFB, Materials Lab., Rept. No. ML-TDR-64-50, Part II (Prepared at National Bureau of Standards, Boulder, Colo., Cryogenics Div., under USAF Delivery Order No. 33(615)64-1002), 100 pages (Mar 1965). Also National Bureau of Standards, Boulder, Colo., Cryogenics Div., Rept. -Unpublished. (\$3.00)⁵
- MR-15 CALCULATION OF THE VAPOR PRESSURE AND HEATS OF VAPORIZATION AND SUBLIMATION OF LIQUIDS AND SOLIDS, ESPECIALLY BELOW ONE ATMOSPHERE. IV. NITROGEN AND FLUORINE, by W. T. Ziegler and J. C. Mullins. Georgia Inst. of Tech., Atlanta, Engineering Experiment Station, Tech. Rept. No. 1 (Prepared under NBS Contr. No. CST-7404), 59 pages (Apr 1963). (PB168896)²
- MR-16 CALCULATION OF THE VAPOR PRESSURE AND HEATS OF VAPORIZATION AND SUBLIMATION OF LIQUIDS AND SOLIDS, ESPECIALLY BELOW ONE ATMOSPHERE. V. CARBON MONOXIDE AND CARBON DIOXIDE, by J. C. Mullins, B. S. Kirk and W. T. Ziegler. Georgia Inst. of Tech., Atlanta, Engineering Experiment Station, Tech. Rept. No. 2 (Prepared under NBS Contr. No. CST-7404), 81 pages (Aug 1963). (PB172349)²
- MR-17 CALCULATION OF THE VAPOR PRESSURE AND HEATS OF VAPORIZATION AND SUBLIMATION OF LIQUIDS AND SOLIDS, BELOW ONE ATMOSPHERE PRESSURE. VI. KRYPTON, by W. T. Ziegler, D. W. Yarbrough and J. C. Mullins. Georgia Inst. of Tech., Atlanta, Engineering Experiment Station, Tech. Rept. No. 1 (Prepared under NBS Contr. No. CST-1154), 44 pages (Jul 1964). (PB172350)²
- MR-18 TABLES OF THERMAL PROPERTIES OF GASES, by J. Hilsenrath, C. W. Beckett, W. S. Benedict, L. Fano, et al. Nat. Bur. Stand. (U.S.), Circ. No. 564, 488 pages (Nov 1955). (Microfiche - \$4.50)⁵ (Pergamon Press, London and New York - \$20.00)⁴
- MR-19 ON THE FORMULATION AND NUMERICAL EVALUATION OF A SET OF TWO-PHASE FLOW EQUATIONS MODELLING THE COOLDOWN PROCESS, by S. Jarvis, Jr. Nat. Bur. Stand. (U.S.), Tech. Note No. 301, 48 pages (Jan 1965). (C13.46:301 - 554)³
- MR-20 CALCULATION OF THE VAPOR PRESSURE AND HEATS OF VAPORIZATION AND SUBLIMATION OF LIQUIDS AND SOLIDS BELOW ONE ATMOSPHERE PRESSURE. VII. ETHANE, by W. T. Ziegler, B. S. Kirk, J. C. Mullins and A. R. Berquist. Georgia Inst. of Tech., Atlanta, Engineering Experiment Station, Tech. Rept. No. 2 (Prepared under NBS Contr. No. CST-1154), 65 pages (Dec 1964). (PB172351)²
- MR-21 STABILITY OF TWO-PHASE ANNULAR FLOW IN A VERTICAL PIPE, by S. Jarvis, Jr. Nat. Bur. Stand. (U.S.), Tech. Note No. 314, 92 pages (Jun 1965). (C13.46:314 - 554)²
- MR-22 THE THERMODYNAMIC PROPERTIES OF OXYGEN, by R. B. Stewart. Iowa Univ., Iowa City, Ph.D. Dissertation, 209 pages (Jun 1966). (\$5.00)⁵

- MR-23 CALCULATION OF THE VAPOR PRESSURE AND HEATS OF VAPORIZATION AND SUBLIMATION OF LIQUIDS AND SOLIDS BELOW ONE ATMOSPHERE PRESSURE. VIII. XENON, by W. T. Ziegler, J. C. Mullins and A. R. Berquist. Georgia Inst. of Tech., Atlanta, Engineering Experiment Station, Tech. Rept. No. 3 (Prepared under NBS Contr. No. CST-1154), 49 pages (Apr 1966). (PB173797)²
- MR-23a THE SYSTEM HELIUM-ARGON FROM 65 TO 140 K UP TO PRESSURES OF 120 ATM. CORRELATION OF AVAILABLE PHASE EQUILIBRIUM DATA, by J. C. Mullins and W. T. Ziegler. Georgia Inst. of Tech., Atlanta, Engineering Experiment Station, Tech. Rept. No. 3 (Prepared under NBS Contr. No. CST-1154), 69 pages (Jan 1965). (Request from Georgia Institute of Technology, Engineering Experiment Station, Atlanta, Ga.)⁴
- MR-24 THERMODYNAMIC PROPERTIES OF ARGON IN THE LIQUID AND GASEOUS STATE FOR TEMPERATURES FROM THE TRIPLE POINT TO 300°K WITH PRESSURES TO 1000 ATMOSPHERES, by A. L. Gosman. Iowa State Univ., Ames, Ph.D. Dissertation, 238 pages (Aug 1965). (Available from University Microfilms, Ann Arbor, Michigan, Order No. 66-3434 - Xerography \$10.80; Microfilm \$3.10)
- MR-25 TWO-PHASE, TWO-COMPONENT CRITICAL FLOW IN A VENTURI, by R. V. Smith. Oxford Univ., England, Ph.D. Dissertation, 235 pages (Jun 1968). (\$4.00)⁶
- MR-26 CALCULATION OF THE VAPOR PRESSURE AND HEATS OF VAPORIZATION AND SUBLIMATION OF LIQUIDS AND SOLIDS BELOW ONE ATMOSPHERE PRESSURE. IX. NEON, by W. T. Ziegler, G. N. Brown and J. D. Garber. Georgia Inst. of Tech., Atlanta, Engineering Experiment Station, Tech. Rept. No. 1 (Prepared under NBS Contr. No. CST-7973), 64 pages (May 1970). (\$2.50)⁶
- MR-27 SPECTRAL RADIATIVE PROPERTIES OF TRANSITION METALS AT LIQUID HELIUM TEMPERATURES, by M. C. Jones. California Univ., Berkeley, Ph.D. Dissertation, 106 pages (Dec 1970). (\$4.00)⁶
- MR-28 TECHNICAL MANUAL OF OXYGEN/NITROGEN CRYOGENIC SYSTEMS. Naval Air Systems Command, Washington, D. C., Rept. No. NAVAIR 06-3-501, 427 pages (Mar 1971). (No charge for single copy)⁶

Thermodynamic Properties Charts

Single copies of the following charts are available from National Bureau of Standards, Cryogenic Data Center, Boulder, Colorado 80302, at no charge. Additional copies of charts D-1 through D-57 may be purchased from National Technical Information Service, Springfield, Virginia 22151 (Order by PB No. --price \$1.00 each regardless of size). Charts D-58 through D-67 are available from NBS Cryogenic Data Center only (request by D No.).

- D-1 TEMPERATURE-ENTROPY DIAGRAM OF HELIUM (1 to 40°K; .001 to 100 atm.). Leiden Univ., Netherlands, Kamerlingh Onnes Lab. (1941). PB172352-1 - 8 1/2" x 11" size; PB172352-3 - 17" x 22" size.
- D-2 TEMPERATURE-ENTROPY DIAGRAM OF HELIUM (20 to 500°K; .03 to 300 atm.). Leiden Univ., Netherlands, Kamerlingh Onnes Lab. (1941). PB172353-1 - 8 1/2" x 11" size; PB172353-3 - 17" x 22" size.
- D-3 TEMPERATURE-ENTROPY DIAGRAM OF HELIUM (20 to 300°K; 0.1 to 100 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1961). From: Nat. Bur. Stand. (U.S.), Res. Pap. 1932 (1948). PB172354-1 - 8 1/2" x 11" size; PB172354-3 - 17" x 22" size.
- D-4 TEMPERATURE-ENTROPY DIAGRAM OF NORMAL HYDROGEN (0 to 150°K; 0.6 to 300 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1960). From: Nat. Bur. Stand. (U.S.), Res. Pap. 1932 (1948). PB172355-1 - 8 1/2" x 11" size; PB172355-3 - 17" x 22" size.
- D-5 TEMPERATURE-ENTROPY DIAGRAM OF NORMAL HYDROGEN (130 to 300°K; 0.8 to 600 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1960). From: Nat. Bur. Stand. (U.S.), Res. Pap. 1932 (1948). PB172356-1 - 8 1/2" x 11" size; PB172356-3 - 17" x 22" size.
- D-6 TEMPERATURE-ENTROPY DIAGRAM OF NEON (55 to 300°K, 0.5 to 90 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: A Compendium of the Properties of Materials at Low Temperature - Phase II. R. B. Stewart and V. J. Johnson (General Editors). Wright Air Development Div., Wright-Patterson AFB, Ohio, Tech. Rept. No. WADD 60-56 (1961). PB172357-1 - 8 1/2" x 11" size; PB172357-3 - 17" x 22" size.
- D-7 TEMPERATURE-ENTROPY DIAGRAM OF NITROGEN (50 to 450°K; 0.1 to 1200 atm.) Bureau of Mines, Amarillo, Tex. From: Chart by E. S. Burnett (1949). PB172358-1 - 8 1/2" x 11" size; PB172358-3 - 17" x 22" size.
- D-8 TEMPERATURE-ENTROPY DIAGRAM OF AIR (70 to 350°K; 1 to 1100 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1961). Based on data from Michels, et al., and Claitor, et al. (1954). PB172359-1 - 8 1/2" x 11" size; PB172359-3 - 17" x 22" size.
- D-9 PRESSURE-ENTHALPY DIAGRAM OF OXYGEN (100 to 300°K; 1 to 70 atm.). Bureau of Mines (1928). PB172360-1 - 8 1/2" x 11" size.
- D-10 PRESSURE-ENTHALPY DIAGRAM OF OXYGEN (-200 to +200°C; 0.10 to 300 atm.). Leiden Univ., Netherlands, Kamerlingh Onnes Lab. (1942). PB172361-1 - 8 1/2" x 11" size; PB172361-3 - 17" x 22" size.
- D-11 PRESSURE-ENTHALPY DIAGRAM OF AIR (90 to 315°K; 1 to 250 atm.). From: Air Products Chart, based on Lundstrom's Data. PB172362-1 - 8 1/2" x 11" size; PB172362-3 - 17" x 22" size.
- D-12 PRESSURE-ENTHALPY DIAGRAM OF CARBON MONOXIDE (-200 to +200°C; 0.15 to 300 atm.). Leiden Univ., Netherlands, Kamerlingh Onnes Lab. (1942). PB172363-1 - 8 1/2" x 11" size; PB172363-3 - 17" x 22" size.
- D-13 COMPRESSIBILITY FACTOR CHART FOR HELIUM; Z vs P (20 to 300°K; 1 to 100 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: A Compendium of the Properties of Materials at Low Temperature - Phase II. R. B. Stewart and V. J. Johnson (General Editors). Wright Air Development Div., Wright-Patterson AFB, Ohio, Tech. Rept. No. WADD 60-56 (1961). PB172364-1 - 8 1/2" x 11" size; PB172364-3 - 17" x 22" size.

- D-14 COMPRESSIBILITY FACTOR CHART FOR NORMAL HYDROGEN; Z vs P (16 to 300°K; .08 to 800 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: A Compendium of the Properties of Materials at Low Temperature - Phase II. R. B. Stewart and V. J. Johnson (General Editors). Wright Air Development Div., Wright-Patterson AFB, Ohio, Tech. Rept. No. WADD 60-56 (1961). PB172365-1 - 8 1/2" x 11" size; PB172365-3 - 17" x 22" size.
- D-15 COMPRESSIBILITY FACTOR CHART FOR NEON; Z vs P (55 to 300°K; 20 to 90 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: A Compendium of the Properties of Materials at Low Temperature - Phase II. R. B. Stewart and V. J. Johnson (General Editors). Wright Air Development Div., Wright-Patterson AFB, Ohio, Tech. Rept. No. WADD 60-56 (1961). PB172366-1 - 8 1/2" x 11" size; PB172366-3 - 17" x 22" size.
- D-16 COMPRESSIBILITY FACTOR CHART FOR NITROGEN; Z vs P (90 to 300°K; 1 to 500 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: A Compendium of the Properties of Materials at Low Temperature - Phase II. R. B. Stewart and V. J. Johnson (General Editors). Wright Air Development Div., Wright-Patterson AFB, Ohio, Tech. Rept. No. WADD 60-56 (1961). PB172367-1 - 8 1/2" x 11" size; PB172367-3 - 17" x 22" size.
- D-17 COMPRESSIBILITY FACTOR CHART FOR NITROGEN; Z vs P (90 to 300°K; 300 to 3000 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: A Compendium of the Properties of Materials at Low Temperature - Phase II. R. B. Stewart and V. J. Johnson (General Editors). Wright Air Development Div., Wright-Patterson AFB, Ohio, Tech. Rept. No. WADD 60-56 (1961). PB172368-1 - 8 1/2" x 11"; PB172368-3 - 17" x 22" size.
- D-18A COMPRESSIBILITY FACTOR CHART FOR AIR; Z vs P (90 to 300°K; 0.1 to 600 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: A Compendium of the Properties of Materials at Low Temperature - Phase II. R. B. Stewart and V. J. Johnson (General Editors). Wright Air Development Div., Wright-Patterson AFB, Ohio, Tech. Rept. No. WADD 60-56 (1961). PB172369-1 - 8 1/2" x 11" size; PB172369-3 - 17" x 22" size.
- D-18B COMPRESSIBILITY FACTOR CHART FOR AIR; Z vs T (75 to 300°K; 1 to 1000 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: A Compendium of the Properties of Materials at Low Temperature - Phase II. R. B. Stewart and V. J. Johnson (General Editors). Wright Air Development Div., Wright-Patterson AFB, Ohio, Tech. Rept. No. WADD 60-56 (1961). PB172370-1 - 8 1/2" x 11" size; PB172370-3 - 17" x 22" size.
- D-19 COMPRESSIBILITY FACTOR CHART FOR METHANE; Z vs P (122 to 273°K; 1 to 600 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: A Compendium of the Properties of Materials at Low Temperature - Phase II. R. B. Stewart and V. J. Johnson (General Editors). Wright Air Development Div., Wright-Patterson AFB, Ohio, Tech. Rept. No. WADD 60-56 (1961). PB172371-1 - 8 1/2" x 11" size; PB172371-3 - 17" x 22" size.
- D-20 TEMPERATURE-ENTROPY CHART FOR PARAHYDROGEN (14 to 100°K; 0.1 to 340 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: Nat. Bur. Stand. (U.S.), Monogr. No. 94 (1965). PB172372-1 - 8 1/2" x 11" size; PB172372-3 - 17" x 22" size.
- D-20A INTERIM TEMPERATURE-ENTROPY CHART FOR PARAHYDROGEN (In Metric Units; 20 to 100°K; 1 to 340 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: Nat. Bur. Stand. (U.S.), Tech. Note No. 130 (1961). PB172373-1 - 8 1/2" x 11" size; PB172373-2 - 11" x 17" size; PB172373-3 - 17" x 22" size.
- D-20B INTERIM TEMPERATURE-ENTROPY CHART FOR PARAHYDROGEN (In British Units; 30 to 180°R; 10 to 5000 psia). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: Nat. Bur. Stand. (U.S.), Tech. Note No. 130 (1961). PB172374-1 - 8 1/2" x 11" size; PB172374-2 - 11" x 17" size; PB172374-3 - 17" x 22" size.
- D-21A INTERIM TEMPERATURE-ENTROPY CHART FOR PARAHYDROGEN (In Metric Units; 80 to 300°K; 1 to 100 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: Nat. Bur. Stand. (U.S.), Tech. Note No. 130 (1961). PB172375-1 - 8 1/2" x 11" size; PB172375-2 - 11" x 17" size; PB172375-3 - 17" x 22" size.
- D-21B INTERIM TEMPERATURE-ENTROPY CHART FOR PARAHYDROGEN (In British Units; 140 to 540°R; 10 to 1500 psia.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: Nat. Bur. Stand. (U.S.), Tech. Note No. 130 (1961). PB172376-1 - 8 1/2" x 11" size; PB172376-2 - 11" x 17" size; PB172376-3 - 17" x 22" size.

- D-22 ENTHALPY-ENTROPY CHART FOR PARAHYDROGEN (16 to 64°K; 0.3 to 340 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: Nat. Bur. Stand. (U.S.), Monogr. No. 94 (1965). PB172377-1 - 8 1/2" x 11" size; PB172377-3 - 17" x 22" size.
- D-22A INTERIM ENTHALPY-ENTROPY CHART FOR PARAHYDROGEN (In Metric Units; 20 to 60°K; 1 to 340 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: Nat. Bur. Stand. (U.S.), Tech. Note No. 130 (1961). PB172378-1 - 8 1/2" x 11" size; PB172378-2 - 11" x 17" size; PB172378-3 - 17" x 22" size.
- D-22B INTERIM ENTHALPY-ENTROPY CHART FOR PARAHYDROGEN (In British Units; 36 to 100°R; 10 to 5000 psia.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: Nat. Bur. Stand. (U.S.), Tech. Note No. 130 (1961). PB172379-1 - 8 1/2" x 11" size; PB172379-2 - 11" x 17" size; PB172379-3 - 17" x 22" size.
- D-23 TEMPERATURE-ENTROPY DIAGRAM FOR NITROGEN (65 to 300°K; 0.1 to 200 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: Nat. Bur. Stand. (U.S.), Tech. Note No. 129 (1962). PB172380-1 - 8 1/2" x 11" size; PB172380-3 - 17" x 22" size.
- D-24 TEMPERATURE-ENTROPY DIAGRAM FOR HELIUM (0 to 50°K; 0.5 to 150 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1957). From: J. Zelmanov, W. H. Keesom and E. H. Brown Data (1940, 1944, 1958). PB172381-1 - 8 1/2" x 11" size.
- D-25 TEMPERATURE-ENTROPY DIAGRAM FOR HELIUM (50 to 100°K; 0.5 to 200 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1957). From: W. H. Keesom Data (1940). PB172382-1 - 8 1/2" x 11" size.
- D-26 TEMPERATURE-ENTROPY DIAGRAM FOR HELIUM (100 to 200°K; 0.5 to 200 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1957). From: W. H. Keesom Data (1940). PB172383-1 - 8 1/2" x 11" size.
- D-27 TEMPERATURE-ENTROPY DIAGRAM FOR HELIUM (200 to 400°K; 0.5 to 200 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1957). From: W. H. Keesom Data (1940). PB172384-1 - 8 1/2" x 11" size.
- D-28 TEMPERATURE-ENTROPY DIAGRAM FOR HYDROGEN (280 to 600°K; 1 to 1200 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1960). From: Nat. Bur. Stand. (U.S.), Res. Pap. 1932 (1948). PB172385-1 - 8 1/2" x 11" size; PB172385-2 - 11" x 17" size.
- D-42 PRESSURE-ENTHALPY DIAGRAM OF ETHYLENE (-150 to +200°C; .02 to 300 atm.). Leiden Univ., Netherlands, Kamerlingh Onnes Lab. (1941). PB172386-1 - 8 1/2" x 11" size; PB172386-3 - 17" x 22" size.
- D-43 PRESSURE-ENTHALPY DIAGRAM OF METHANE (90 to 480°K; 1 to 300 atm.). Leiden Univ., Netherlands, Kamerlingh Onnes Lab. (1940). PB172387-1 - 8 1/2" x 11" size; PB172387-3 - 17" x 22" size.
- D-44 COMPRESSIBILITY FACTOR CHART FOR NEON; Z vs P (30 to 300°K; 1 to 200 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1962). From: "P-p-T Values for Neon from 27° to 300°K for Pressures to 200 Atmospheres Using Corresponding States Theory," by R. D. McCarty, R. B. Stewart and K. D. Timmerhaus. *Advances in Cryogenic Engineering*, Vol 8, Plenum Press, New York (1963). PB172388-1 - 8 1/2" x 11" size; PB172388-3 - 17" x 22" size.
- D-45 INTERIM TEMPERATURE-ENTROPY CHART FOR LIQUID OXYGEN (54 to 100°K; saturated liquid to 200 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1963). An extension of the chart contained in The Thermodynamic Properties of Oxygen From 20° to 100°K, by J. C. Mullins, W. T. Ziegler and B. S. Kirk. Georgia Inst. of Tech., Atlanta, Engineering Experiment Station, Tech. Rept. No. 2 (Prepared under NBS Contr. No. CST-7339) (Mar 1962). PB172389-1 - 8 1/2" x 11" size; PB172389-2 - 11" x 17" size.
- D-46 TEMPERATURE-ENTROPY DIAGRAM FOR OXYGEN (30 to 100°K; 10⁻⁶ to 1750 mm Hg.). Reprinted from: The Thermodynamic Properties of Oxygen From 20° to 100°K, by J. C. Mullins, W. T. Ziegler, and B. S. Kirk. Georgia Inst. of Tech., Atlanta, Engineering Experiment Station, Tech. Rept. No. 2 (Prepared under NBS Contr. No. CST-7339) (Mar 1962). PB172390-3 - 17" x 22" size.

- D-47 TEMPERATURE-ENTROPY DIAGRAM FOR PARAHYDROGEN (4 to 22°K; 10^{-6} to 1000 mm Hg.). Reprinted from: The Thermodynamic Properties of Parahydrogen from 1° to 22°K, by J. C. Mullins, W. T. Ziegler and B. S. Kirk. Georgia Inst. of Tech., Atlanta, Engineering Experiment Station, Tech. Rept. No. 1 (Prepared under NBS Contr. No. CST-7339) (Nov 1961). PBI72391-2 - 11" x 17" size.
- D-48R TEMPERATURE-ENTROPY DIAGRAM FOR NEON (60 to 300°K; 0.1 to 200 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1963). Reprinted from: "Thermodynamic Properties of Neon from 25 to 300°K between 0.1 and 200 Atmospheres," by R. D. McCarty and R. B. Stewart. Advances in Thermophysical Properties at Extreme Temperatures and Pressures, 84-97. American Society of Mechanical Engineers, New York (1965). PBI72392-1 - 8 1/2" x 11" size; PBI72392-3 - 17" x 22" size.
- D-49R TEMPERATURE-ENTROPY DIAGRAM FOR NEON (25 to 80°K; 0.1 to 200 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1963). Reprinted from: "Thermodynamic Properties of Neon from 25 to 300°K between 0.1 and 200 Atmospheres," by R. D. McCarty and R. B. Stewart. Advances in Thermophysical Properties at Extreme Temperatures and Pressures, 84-97. American Society of Mechanical Engineers, New York (1965). PBI72393-1 - 8 1/2" x 11" size; PBI72393-3 - 17" x 22" size.
- D-50 COMPRESSIBILITY FACTOR CHART FOR CARBON MONOXIDE; Z vs P (100 to 300°K; 1 to 300 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. Reprinted from: Nat. Bur. Stand. (U.S.), Tech. Note No. 202 (Sep 1963). PBI72394-1 - 8 1/2" x 11" size; PBI72394-3 - 17" x 22" size.
- D-51 TEMPERATURE-ENTROPY DIAGRAM FOR CARBON MONOXIDE (70 to 300°K; 0.1 to 300 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. Reprinted from: Nat. Bur. Stand. (U.S.), Tech. Note No. 202 (Sep 1963). PBI72395-1 - 8 1/2" x 11" size; PBI72395-3 - 17" x 22" size.
- D-52 TEMPERATURE-ENTROPY DIAGRAM FOR HELIUM (15 to 300°K; 0.1 to 100 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1964). From: Nat. Bur. Stand. (U.S.), Tech. Note No. 154 (Jan 1962). PBI72396-1 - 8 1/2" x 11" size; PBI72396-3 - 17" x 22" size.
- D-53 TEMPERATURE-ENTROPY DIAGRAM FOR HELIUM (3 to 25°K; 0.5 to 100 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1964). From: Nat. Bur. Stand. (U.S.), Tech. Note No. 154 (Jan 1962). PBI72397-1 - 8 1/2" x 11" size; PBI72397-3 - 17" x 22" size.
- D-54 ENTHALPY-ENTROPY CHART FOR HELIUM (3 to 25°K; 1 to 100 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1964). From: Nat. Bur. Stand. (U.S.), Tech. Note No. 154 (Jan 1962). PBI72398-1 - 8 1/2" x 11" size; PBI72398-3 - 17" x 22" size.
- D-55 VELOCITY OF SOUND IN GASEOUS HYDROGEN (20 to 300°K; 36 to 500°R). National Bureau of Standards, Boulder, Colo., Cryogenics Div. (1960). From: Nat. Bur. Stand. (U.S.), Res. Pap. 1932 (1948). PBI92399-2 - 11" x 17" size.
- D-56 TEMPERATURE-ENTROPY CHART FOR OXYGEN (65 to 300°K; .002 to 340 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: The Thermodynamic Properties of Oxygen, by R. B. Stewart. Ph. D. Dissertation, University of Iowa, Iowa City (1966). PBI73078-1 - 8 1/2" x 11" size; PBI73078-2 - 11" x 17" size; PBI73078-3 - 17" x 22" size.
- D-57 COMPRESSIBILITY FACTOR CHART FOR OXYGEN (70 to 300°K; 1 to 340 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: The Thermodynamic Properties of Oxygen, by R. B. Stewart. Ph. D. Dissertation, University of Iowa, Iowa City (1966). PBI73079-1 - 8 1/2" x 11" size; PBI73079-3 - 17" x 22" size.
- D-58 TEMPERATURE-ENTROPY CHART FOR DEUTERIUM (20 to 100°K; 0.1 to 100 atm.). National Bureau of Standards, Boulder, Colo., Cryogenics Div. From: The Thermodynamic Properties of Deuterium, by R. Prydz. M.S. Thesis, University of Colorado, Boulder (1967). 8 1/2" x 11" size and 11" x 17" size.
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Author Index*

Aboud, A. A.	R-89
Allen, J. W.	<u>R-18</u> , R-19
Alspach, W. J.	<u>R-353</u> , R-387, <u>R-403</u>
Anderson, A. C.	R-680
Anderson, L. M.	R-699
Armstrong, G. T.	<u>R-1</u> , <u>R-34</u>
Arnett, R. W.	<u>R-115</u> , <u>R-200</u> , <u>R-249</u> , <u>R-359</u> , <u>R-700</u> , <u>MR-5</u>
Arp, V. D.	<u>R-179</u> , <u>R-187</u> , <u>R-190</u> , R-212, R-231, <u>R-237</u> , <u>R-277</u> , R-289, <u>R-375</u> , <u>R-385</u> , <u>R-513</u> , <u>R-554</u> , <u>R-561</u> , R-590, R-658, <u>R-710</u>
Arvidson, J. M.	R-670
Ashley, J. R.	R-694
Barker, J. A.	R-725
Barrick, P. L.	<u>R-28</u> , R-189
Beck, D. R.	R-294
Beckett, C. W.	MR-18
Benedict, W. S.	MR-18
Berquist, A. R.	MR-20, MR-23
Birmingham, B. W.	<u>R-8</u> , <u>R-36</u> , <u>R-57</u> , <u>R-61</u> , R-79, <u>R-119</u> , R-121, <u>R-132</u> , R-153, R-154, R-156, R-169, R-192, <u>R-194a</u> , <u>R-194b</u> , <u>R-199</u> , R-211, R-221, R-281, R-283, <u>R-361</u> , R-472, R-475, R-499, <u>R-505</u> , R-526
Ejorklund, W. R.	R-145, R-176, R-180, <u>R-337</u>
Blake, J. H.	R-112, R-149
Blanpied, W. A.	R-5
Bloom, D. W.	<u>R-603</u>
Boggs, R. N.	R-114
Bopp, G. R.	R-176, R-180
Boyd, M. E.	<u>R-419</u>
Braudaway, D. W.	<u>R-19</u>
Breedis, J. F.	R-388
Brennan, J. A.	R-192, <u>R-194a</u> , <u>R-194b</u> , R-201, <u>R-291</u> , R-398, <u>R-451</u> , R-469, <u>R-532</u> , R-533, R-578, <u>R-650</u> , R-667, <u>R-709</u> , <u>R-727</u>
Brennand, J. R.	R-107a, R-107b
Brentari, E. G. F.	R-290, <u>R-316</u> , <u>R-357</u> , <u>R-368</u>
Brickwedde, F. G.	R-1, <u>R-7</u> , R-34, MR-1
Brooks, L.	R-254
Brown, E. H.	R-8, R-29, R-57, <u>R-72</u> , <u>R-90</u> , <u>R-107a</u> , <u>R-107b</u> , R-119, <u>R-155</u> , <u>R-172</u> , <u>R-222</u>
Brown, G. N.	MR-26
Brown, J. D.	R-24

*Underline indicates first author.

Bunch, M. D. R-83, R-102, R-103, R-161, R-185, R-188, R-258

Burgess, R. R-253

Burgeson, D. A. R-292

Burley, R. M. R-308

Byrns, R. A. R-54

Catalano, E. R-23

Caywood, L. P. R-185, R-208, R-258

Chapman, T. W. R-449

Chelton, D. B. R-54, R-63, R-65, R-74, R-132, R-153, R-154, R-169, R-201, R-221, R-281, R-296,
R-394, R-404, R-421, R-458

Childs, G. E. R-410, R-420, R-454, R-456, R-503, R-519, R-573, R-575, R-592

Chueh, P. L. R-415, R-446

Clark, A. F. R-366, R-369, R-470, R-483, R-502, R-510, R-575, R-592, R-619, R-628, R-642, R-643,
R-659, R-687, R-698, R-715

Class, C. R. R-8, R-57

Cline, D. R-209, R-231, R-239, R-240

Coffin, D. O. R-27, R-32, R-67

Collier, R. S. R-272, R-342, R-383, R-385, R-535, R-675

Connolly, T. W. R-28

Corruccini, R. J. R-22, R-64, R-86, R-100, R-103, R-123, R-167, R-171, R-173, R-188, R-191, R-232,
R-233, R-238, R-259, R-266, R-308, R-326, R-332, R-365, R-367, R-377, R-412, MR-13

Cousins, L. B. R-518

Craig, T. S. R-277

Crim, J. A. R-230

Cruz, J. E. R-588, R-673

Cupp, J. D. R-543, R-622, R-623, R-694

Curtis, G. W. R-24

Daney, D. R-447, R-458, R-467, R-489, R-509, R-536, R-580, R-615, R-641

Dean, J. W. R-63, R-74, R-90, R-153, R-154, R-169, R-217, R-235, R-250, R-254, R-262, R-281,
R-343, R-345, R-400, R-466, R-533, R-650, R-667, R-709

Deason, V. A. R-643, R-687, R-698

Devereux, R. J. R-49

Dickson, P. F. R-409, R-455, R-465, R-528, R-570

Diller, D. E. R-226, R-236, R-269, R-270, R-276, R-278, R-315, R-319, R-349, R-397, R-482, R-572,
R-573, R-582, R-594, R-646

Dillinger, J. R. R-103, R-104, R-105

Draper, J. W. R-42, R-44, R-76, R-77, R-80, R-91

Drayer, D. E. R-195, R-196, R-197, R-204, R-244, R-262, R-350

Duncan, A. G. R-504, R-523, R-527, R-562, R-597, R-669

Durcholz, R. L. R-576, R-649, R-666, R-670

Eckert, C. A. R-334, R-417, R-418

Edmonds, D. K. R-273, R-290, R-406, R-451, R-490, R-531, R-532

Ellerbruch, D. A. R-630, R-674

Evenson, K. M. R-543, R-622, R-623, R-694

Fano, L. MR-18

Ferguson, J. F. R-261

Fickett, F. R. R-502, R-510, R-617, R-619, R-626, R-656, R-678

Finegold, L. R-603

Flynn, T. M. R-44, R-76, R-96, R-116a, R-116b, R-163, R-165, R-181a, R-181b, R-181c, R-195, R-196, R-197, R-244, R-343, R-353, R-384, R-387, R-392, R-400, R-403, R-411, R-428, R-430, R-492, R-505, R-526

Frederick, N. V. R-639

Frost, W. M. R-146, R-162

Fulk, M. M. R-18, R-20, R-24, R-25, R-49, R-58, R-70, R-138, R-141, R-143, R-308

Garber, J. D. MR-26

Germann, F. E. R-596

Giarratano, P. J. R-368, R-396, R-508, R-541, R-614, R-658

Gibbons, H. P. R-168

Gibson, E. F. R-161, R-170

Gniewek, J. J. R-171, R-173, R-191, R-202, R-314, R-364, R-366, R-369, R-506

Goodman, B. E. R-472

Goodwin, R. D. R-60, R-82, R-95, R-118, R-152, R-183, R-220, R-224, R-226, R-236, R-271, R-276, R-278, R-279, R-299, R-312, R-315, R-319, R-360, R-413, R-429, R-492, R-495, R-496, R-538, R-558, R-585, R-607, R-608, R-609, R-612, R-681, R-705, R-719, R-720

Gosman, A. L. R-301, R-327, R-493, MR-24, MR-28

Grady, T. K. R-384

Gray, A. M. R-390

Greeson, R. L. R-147

Guevara, F. A. R-661

Gunn, R. D. R-415

Guntner, C. J. R-186, R-206, R-234, R-341

Gygax, S. R-324, R-328, R-333, R-379

Hall, L. A. R-230, R-327, R-347, R-459, R-461, R-546, R-596

Hall, W. J. R-88, R-104, R-105, R-129, R-135, R-160, R-315, R-534, R-699, R-713, R-726

Hanley, H. J. M. R-382, R-391, R-410, R-420, R-445, R-453, R-454, R-456, R-481, R-497, R-503, R-519, R-520, R-581, R-594, R-616, R-661, R-668, R-703, R-724, R-725

Harden, J. L. R-170, R-272, R-289

Hardy, R. J. R-52, R-81, R-127

Hartwig, W. H. R-472

Hatch, M. R. R-114, R-215

Heck, C. K. R-431, R-464, R-474

Hendricks, R. C. R-577, R-633

Hernandez, H. P. R-132

Herring, R. N. R-203, R-282, R-356, MR-9

Hershey, R. L. R-15

Hewitt, G. F. R-518

Hilsenrath, J. MR-18

Hiza, M. J. R-84a, R-84b, R-94, R-145, R-174, R-184, R-189, R-244, R-248, R-282, R-298, R-344, R-356, R-381, R-395, R-414, R-422, R-431, R-442, R-464, R-465, R-474, R-504, R-523, R-527, R-528, R-562, R-569, R-570, R-593, R-597, R-606, R-640, R-669, R-722

Holten, D. C. R-87, R-138

Hord, J. R-339, R-370, R-408, R-433, R-435, R-439, R-480, R-490, R-531, R-605, R-692, MR-28

Hunter, B. J. R-141, R-143

Hust, J. G. R-230, R-301, R-306, R-327, R-380, R-440, R-484, R-493, R-515, R-549, R-567, R-610, R-636, R-642, R-664, R-696, R-697, R-698, R-702, R-716

Intemann, H. R-581

Jacobs, R. B. R-11, R-33, R-48, R-52, R-53, R-55, R-62, R-81, R-87, R-92, R-111, R-114, R-117a, R-117b, R-124, R-127, R-140, R-142, R-144, R-157, R-164, R-166, R-198, R-210, R-215, R-219, R-252, R-261, R-265, R-273, R-274, R-275, R-288, R-331, R-339, R-373, R-374, R-416

Jarvis, S., Jr. MR-19, MR-21

Jellison, J. C. R-535, R-588, R-675

Jensen, J. E. R-13

Johnson, V. J. R-2, R-30, R-43, R-71, R-75, R-100, R-130, R-150, R-151, R-309, R-321, R-460, R-485, R-525, MR-3, MR-4a, MR-4b, MR-4c, MR-7, MR-18

Jones, M. C. R-398, R-409, R-455, R-508, R-516, R-541, R-542, R-548, R-566, R-686, MR-27

Kamper, R. A. R-342, R-383, R-385, R-441, R-448, R-478, R-479, R-491, R-544, R-545, R-621, R-627, R-652, R-660, R-691

Kasen, M. B. R-521, R-565, R-584, R-676

Keeler, R. N. R-113, R-149, R-159

Kidnay, A. J. R-184, R-248, R-298, R-381, R-395, R-402, R-414, R-422, R-464, R-465, R-474, R-528, R-570, R-593, R-606, R-640

Kirgis, J. B. R-615

Kirk, B. S. MR-6, MR-8, MR-10, MR-11, MR-12, MR-16, MR-20

Klein, M. R-453, R-481, R-520, R-616, R-668, R-703, R-725

Kneebone, C. H. R-650, R-667, R-709, R-727

Knight, B. L. R-392, R-530

Konecnik, M. R-112, R-149

Kose, V. E. R-543, R-558, R-602

Kreith, F. R-254, R-294, R-542

Kropschot, R. H. R-16, R-26, R-46, R-47, R-56, R-133, R-134, R-141, R-143, R-179, R-187, R-190, R-193, R-209, R-212, R-223, R-231, R-240, R-253, R-277, R-324, R-328, R-333, R-379, R-475, R-479, R-506, R-507, R-530, R-628, R-672

Lang, S. B. R-390, R-407, R-500, R-557

Larsen, S. Y. R-419

Lauritzen, J. I. MR-13

Lawless, W. N. R-635

Ledbetter, H. M. R-586, R-600, R-624, R-654, R-692, R-693, R-704, R-721

Lee, Y. T. R-725

Liley, P. E. R-668

Lipsicas, M. R-486

Loebenstein, W. V. R-91

Lonberger, S. T. MR-13

Love, W. F. R-190

Lowe, L. T. R-673

Ludtke, P. R. R-255, R-320, R-325, R-329, R-394, R-404, R-458, R-489, R-536, R-579, R-663, MR-9, MR-14a, MR-14b, MR-14c

Lye, R. G. R-603

Macinko, J. R-9, R-63, R-74, R-120, R-145, R-274

Mann, D. B. R-9, R-54, R-72, R-120, R-121, R-122, R-126, R-132, R-136, R-145, R-154, R-156, R-221, R-242, R-264, R-283, R-287, R-323, R-345, R-355, R-394, R-399, R-404, R-438, R-447, R-475, R-476, R-533, R-583, R-645, R-650, R-667, R-673, R-709, R-718, R-727

Martin, K. B. R-12, R-52, R-81, R-117a, R-117b, R-127, R-192, R-265, MR-3

Mason, E. A. R-397

Maxwell, E. R-3, R-4, R-101

McCarty, R. D. R-222, R-246, R-293, R-346, R-440, R-460, R-493, R-497, R-581, R-638, R-701, R-723, R-724, R-726

McClintock, R. M. R-46, R-51, R-84a, R-84b, R-94, R-99, R-110, R-131, R-134, R-168, R-182, R-207, R-222, R-267, R-284

McConnell, P. M. R-615

McDonald, D. G. R-543, R-622, R-623, R-694

McInteer, E. B. R-661

McIntosh, G. E. R-9, R-100

Meissner, H. R-385

Meyer, J. W. R-478

Mikesell, R. P. R-40, R-47, R-56, R-85, R-98, R-108, R-109, R-147, R-207, R-352, R-401, R-434, R-443

Miller, C. E. R-274, R-343, R-384, R-387, R-403, R-416, R-428, R-486

Miller, R. C. R-524, R-640

Millhiser, D. R. R-249, R-359

Moulder, J. C. R-366, R-506

Muhlenhaupt, R. C. R-300, R-432, R-457, R-471

Mullen, L. O. R-115, R-142, R-275, R-344, R-373, R-442, R-517, R-539, R-545, MR-5

Mullins, J. C. MR-6, MR-8, MR-10, MR-11, MR-12, MR-15, MR-16, MR-17, MR-20, MR-23

Myer, C. R. R-17

Myers, A. L. R-243, R-351, R-402

Nagamoto, T. T. R-398

Norton, M. T. R-311, R-393, R-457

Ohuri, Y. R-256, R-342, MR-9, MR-14a, MR-14b

Olien, N. A. R-303, R-347, R-625, R-632

Olsen, J. L. R-324, R-379

Orentlicher, M. R-340

Otteson, D. R-661

Palmer, D. C. R-516, R-686

Park, O. E. R-12, R-20, R-24, R-25, R-38, R-42, R-91

Parson, J. M. R-725

Patrician, T. J. R-649, R-654, R-693

Payne, E. G. R-178, R-304

Pestalozzi, W. G. R-111, R-292

Peterson, R. L. R-602

Phelan, R. R-190

Phelps, G. R. R-114

Plöge, E. R-364

Powell, R. L. R-5, R-27, R-32, R-50, R-67, R-68, R-83, R-88, R-89, R-97, R-102, R-103, R-104, R-105, R-129, R-135, R-160, R-161, R-170, R-185, R-188, R-202, R-208, R-258, R-307, R-378, R-386, R-426, R-427, R-444, R-470, R-484, R-488, R-510, R-515, R-534, R-560, R-610, R-631, R-643, R-644, R-664, R-680, R-687, R-689, R-698, R-706, R-713

Prausnitz, J. M. R-243, R-302, R-334, R-340, R-351, R-358, R-415, R-417, R-418, R-446, R-449, R-524

Preston, G. T. R-449

Probert, W. H. R-249

Prydz, R. R-487, R-564, R-568, R-589, R-595, R-598, R-607, R-608, R-611, R-671, R-681, R-683, R-705

Purcell, J. R. R-60, R-80, R-144, R-148a, R-148b, R-159, R-178, R-214, R-288, R-304

Rabb, D. D. R-10

Radebaugh, R. R-194a, R-194b, R-452, R-599, R-603, R-629, R-635, R-647, R-648, R-652, R-653, R-657, R-682

Rapial, A. S. R-509, R-580

Reed, R. P. R-85, R-98, R-108, R-109, R-147, R-186, R-205, R-206, R-234, R-241, R-285, R-341, R-352, R-388, R-401, R-405, R-425, R-434, R-437, R-443, R-463, R-529, R-537, R-576, R-586, R-590, R-649, R-655, R-659, R-666, R-670, R-693, R-714

Renon, H. R-417, R-418

Reynolds, M. M. R-18, R-20, R-24, R-25, R-70, R-308

Rice, L. H. R-500, R-557

Richards, R. J. R-11, R-14a, R-14b, R-33, R-55, R-87, R-92, R-111, R-114, R-140, R-219, R-273, R-290, R-292, R-374, R-466, R-673

Risley, A. S. R-623, R-694

Robbins, R. F. R-87, R-156, R-176, R-180, R-203, R-256, R-320, R-329, R-463, R-522, R-550, MR-9, MR-14a, MR-14b, MR-14c

Robinson, C. C. R-339

Roder, H. M. R-50, R-68, R-88, R-104, R-105, R-129, R-160, R-220, R-226, R-236, R-263, R-276, R-278, R-279, R-312, R-315, R-319, R-360, R-376, R-450, R-460, R-572, R-582, R-583, R-594, R-726

Rogers, W. M. R-50, R-67, R-68, R-97, R-135

Rubin, L. G. R-680

Sarkes, L. A. R-632

Schmidt, A. F. R-8, R-57, R-101, R-144, R-148a, R-148b, R-257, R-348, R-479, MR-28

Schramm, R. E. R-537, R-637, R-649, R-659, R-666

Schrodt, J. E. R-49, R-58, R-141, R-143

Schwartz, S. B. R-11, R-19, R-21, R-22

Scott, L. E. R-156, R-201, R-286

Scott, R. B. R-1, R-34, R-35, R-37, R-40, R-59, R-100, R-119, R-137, R-158, R-213, R-313, MR-1, MR-2

Shaw, S. A. R-500, R-557

Shenker, H. MR-13

Siegwarth, J. D. R-599, R-603, R-629, R-647, R-648, R-652, R-653, R-657, R-679, R-682

Sikora, P. R-237

Silver, A. H. R-441

Simmonds, M. B. R-691

Simoneau, R. J. R-577, R-633

Simpson, A. U. R-508, R-541, R-542

Sindt, C. F. R-394, R-392, R-404, R-458, R-467, R-489, R-536, R-579, R-613, R-663

Sixsmith, H. R-199, R-211, R-216, R-283, R-330, R-372, R-614

Smelser, P. R-251, R-300

Smith, M. C. R-10

Smith, R. V. R-148a, R-148b, R-247, R-260, R-261, R-290, R-297, R-310, R-316, R-357, R-368, R-396, R-406, R-451, R-469, R-494, R-498, R-514, R-518, R-532, R-555, R-577, R-578, R-633, R-651, R-658, R-685, R-695, MR-25, MR-28

Smull, W. E. R-29

Snyder, N. S. R-547, R-563

Soulen, R. J. R-635

Sparks, L. L. R-339, R-427, R-444, R-488, R-534, R-644, R-689, R-696, R-697, R-702, R-706, R-713

Staveley, L. A. K. R-601

Steward, W. G. R-140, R-219, R-354, R-374, R-469, R-578

Stewart, J. W. R-338

Stewart, R. B. R-126, R-136, R-150, R-229, R-230, R-246, R-260, R-293, R-295, R-306, R-322, R-346, R-380, R-487, MR-7, MR-22

Stober, A. K. R-130

Stokes, R. W. R-727

Straty, G. C. R-501, R-564, R-568, R-587, R-589, R-595, R-598, R-611, R-671, R-677, R-717

Strobridge, T. R. R-154, R-218, R-260, R-268, R-323, R-355, R-421, R-432, R-471, R-477, R-511, R-512, R-540, R-552

Sullivan, D. B. R-517, R-545, R-558, R-602, R-634, R-665, R-679, R-684

Timmerhaus, K. D. R-6, R-41, R-42, R-44, R-73, R-76, R-96, R-106, R-113, R-116a, R-116b, R-128, R-139, R-177, R-204, R-245, R-246, R-250, R-262, R-280, R-295, R-317, R-362, R-363, R-392, R-423, R-424, R-430, R-473, R-487, R-500, R-530, R-542, R-553, R-591, R-595, R-711, R-712

Vander Arend, P. C. R-9, R-44, R-79, R-119, R-122

Van Gundy, D. A. R-46, R-48, R-134, R-142, R-373, R-374

Van Valin, C. C. R-42, R-77

Verbeke, O. B. R-707

Voth, R. O. R-393, R-605, R-700, R-708

Wagner, P. R-631

Wallace, G. H. R-575, R-592

Wallace, L. D. R-230

Warren, K. A. R-115, R-182, R-285, MR-5

Waugh, J. S. R-384

Wayman, C. M. R-624, R-692, R-721

Weaver, P. R. R-29

Weber, L. A. R-226, R-236, R-276, R-278, R-299, R-312, R-315, R-319, R-360, R-492, R-496, R-551, R-559, R-571, R-604, R-618, R-638, R-701

Weitzel, D. H. R-15, R-28, R-31, R-38, R-42, R-44, R-66, R-76, R-77, R-78, R-80, R-91, R-96, R-112, R-116a, R-116b, R-128, R-149, R-176, R-180, R-203, R-255, R-256, R-320, R-436, R-467, R-484, R-522, R-610, R-664, R-673, MR-9, MR-14a, MR-14b, MR-14c

Wells, J. S. R-543, R-622

Wergin, P. C. R-261

White, L. E. R-31

Williams, W. E. R-3, R-4

Wilson, A. E. R-21, R-22

Wilson, J. H. R-190, R-231, R-237

Wilson, W. A. R-30, R-45, R-78, R-148a, R-148b, R-192, R-194a, R-194b, R-199, R-211, R-283, R-330, R-393

Winrich, L. R-237

Woolley, H. W. MR-1

Yarbrough, D. W. MR-17

Younglove, E. A. R-269, R-270, R-315, R-371, R-371a, R-462, R-468, R-574, R-587, R-677, R-690, R-717
Ziegler, W. T. R-125, MR-6, MR-8, MR-10, MR-11, MR-12, MR-15, MR-16, MR-17, MR-20, MR-23, MR-26
Zimmerman, J. E. R-441, R-602, R-620, R-621, R-639, R-652, R-662, R-665, R-688

Subject Index

Adhesives R-84, R-94, R-146, R-162, R-189, R-550

Air Properties R-546, D-8, D-11, D-18A, D-18B

Alloys

Aluminum Properties R-88, R-104, R-109, R-160, R-288, R-332, R-513, R-565, R-584, R-626, R-714

Argon Properties R-327, R-389, R-493, R-519, MR-11, MR-24, D-61, D-62, R-724, R-725

Bearings R-81, R-117, R-192, R-194, R-201, R-216, R-372

Bubble Chambers R-54, R-65, R-132, R-479

Carbon Dioxide Properties MR-16

Carbon Monoxide Properties R-306, MR-16, D-12, D-50, D-51

Cool Down R-122, R-252, R-254, R-354, R-469, R-578

Copper Properties R-105, R-129, R-134, R-378, R-434, R-443, R-470, R-506, R-510, R-619

Cryobiology R-316, R-498

Cryogenic Data Center R-151, R-303, R-309, R-485, R-625

Cryogenic Engineering R-2, R-6, R-7, R-7A, R-35, R-39, R-41, R-69, R-73, R-100, R-106, R-124, R-137, R-139, R-158, R-175, R-177, R-213, R-245, R-260, R-280, R-313, R-317, R-321, R-335, R-361, R-362, R-363, R-423, R-424, R-473, R-475, R-499, R-505, R-507, R-512, R-525, R-526, R-553, R-560, R-591, MR-28, R-711, R-712

Cryogenic Equipment R-323

Cryogenic Magnet R-107, R-179, R-212, R-214, R-304, R-305, R-370, R-375, R-479

Cryopumping R-275, R-344, R-408, R-442, R-479

Cryostat R-93, R-101, R-118, R-182, R-205, R-228, R-267, R-284

Deuterium Properties R-487, R-573, D-58, D-59, D-60

Dewars R-8, R-45, R-57, R-59, R-61, R-79, R-120, R-254, MR-5

Distillation R-44, R-76, R-96, R-116, R-128, R-163, R-181

Elastomers R-203, R-256, R-463, MR-14A, MR-14B, MR-14C

Electrical Properties (Solids) R-557

Electrical Resistance R-20, R-89, R-161, R-407, R-426, R-459, R-565, R-575, R-592, R-596, R-617, R-634, R-643, R-656, R-687, R-698, R-716

Emissivity R-25, R-70, R-209, R-238, R-239, R-308, R-455, MR-27

Ethylene Properties MR-10, D-42

Expansion Engine R-13

Expansion Turbines R-155, R-199, R-227, R-283, R-311

Flow Measurement R-16, R-18, R-111, R-144, R-261, R-274, R-353, R-403, R-416, R-451, R-533 R-630, R-645, R-650, R-667, R-709, R-718, R-727

Fluid Cavitation R-198, R-265, R-339, R-490, R-531, R-605, R-699

Fluid Flow R-62, R-114, R-215, R-247, R-291, R-297, R-310, R-406, R-435, R-480, R-489 R-508, R-518, R-532, MR-19, MR-21, MR-25, R-651, R-685, R-695, R-710

Fluid Heat Transfer R-273

Fluorine Properties R-564, R-568, R-595, R-598, R-607, R-608, R-611, MR-15, R-671, R-717

Gas Adsorption	R-184, R-248, R-298, R-402, R-422, R-465, R-528, R-570, R-593
Gas Analysis	R-15, R-31, R-80, R-159
Gas Liquefaction	R-9, R-30, R-36, R-63, R-71, R-74, R-79, R-90, R-121, R-145, R-154, R-286
Gas-Lubricated Bearings	R-199, R-211, R-330
Glass Properties	R-47, R-56
Handling Gases	R-348
Heat Capacity	R-173, R-628
Heat Transfer	R-86, R-87, R-123, R-204, R-219, R-262, R-290, R-318, R-350, R-357, R-368, R-396, R-398, R-494, R-514, R-541, R-542, R-547, R-555, R-561, R-563, R-567, R-577, R-633, R-658
Helium	R-605
Helium Phenomena	
Helium Properties	R-126, R-136, R-229, R-242, R-264, R-450, R-452, R-476, R-503, D-1, D-2, D-3, D-13, D-24, D-25, D-26, D-27, D-52, D-53, D-54, R-648, R-723
Hydrocarbon Properties	MR-20
Hydrogen Handling	R-536
Hydrogen Properties	R-150, R-155, R-183, R-217, R-220, R-224, R-226, R-232, R-235, R-236, R-269, R-270, R-271, R-276, R-278, R-279, R-312, R-315, R-319, R-336, R-338, R-338A, R-349, R-349A, R-360, R-365, R-367, R-371, R-371A, R-382, R-384, R-399, R-412, R-413, R-419, R-429, R-447, R-458, R-462, R-468, R-482, R-486, R-489, R-548, R-556, R-572, R-579, R-581, MR-1, MR-6, D-4, D-5, D-14, D-20, D-20A, D-20B, D-21A, D-21B, D-22, D-22A, D-22B, D-28, D-47, D-55, R-701, R-726
Instrumentation	R-3, R-4, R-60, R-95, R-118, R-127, R-251, R-294, R-343, R-387, R-390, R-400, R-411, R-478, R-502, R-567, R-587, R-588, R-589, R-673, R-674, R-675
Insulating Supports	R-40, R-115, R-119
Laboratory Apparatus	R-152, R-187, R-207, R-209, R-224, R-331, R-337, R-677
Liquefied Natural Gas	R-632
Liquid Level	R-19, R-21, R-292, R-300, R-392, R-535
Magnetic Properties	R-107, R-202, R-364
Mathematical Tables	R-97, R-135, R-440
Mechanical Properties	R-26, R-46, R-47, R-56, R-72, R-85, R-98, R-99, R-109, R-110, R-134, R-147, R-168, R-207, R-267, R-285, R-529, R-576, R-590, R-649
Metallurgy	R-108, R-206, R-241, R-314, R-341, R-366, R-369, R-388, R-405, R-425, R-437, R-521, R-537, R-586, R-600, R-624, R-637, R-654, R-659, R-666, R-676, R-678, R-692, R-693, R-704, R-721
Metals Properties	R-5, R-170, R-515, R-631, R-636, R-655
Methane Properties	R-1, R-34, R-461, R-583, R-609, R-612, MR-12, D-19, D-43, R-663, R-681, R-705, R-719, R-720
Neon Properties	R-246, R-293, R-346, MR-26, D-6, D-15, D-44, D-48, D-49
Nitrogen Properties	R-218, R-263, R-268, R-604, MR-15, D-7, D-16, D-17, D-23
Optical Properties	R-409, R-516, R-566, R-573, R-686
Ortho-Para Conversion	R-28, R-38, R-42, R-43, R-66, R-77, R-78, R-91, R-112, R-113, R-149
Oxygen Detection	R-22, R-23
Oxygen Properties	R-200, R-230, R-249, R-492, R-495, R-496, R-551, R-559, R-571, R-574, R-618, R-638, MR-8, MR-22, D-9, D-10, D-45, D-46, D-56, D-57, D-63, D-64, D-65, D-66, D-67, R-683, R-690

Physical Equilibria	R-165, R-195, R-196, R-197, R-244, R-282, R-302, R-326, R-334, R-340, R-351, R-356, R-358, R-395, R-414, R-431, R-464, R-474, R-523, R-524, R-527, R-562, R-569, R-597, R-601, R-640, R-669, R-722
Plastics	R-99, R-522, R-615, R-670
Pressure Measurement	R-439
Properties of Fluid	R-307, R-347, R-446, R-453, R-487, R-520, R-577, R-585, R-616, MR-4A, MR-17, MR-23
Properties of Materials	R-64, R-223, MR-4C, MR-7
Properties of Solids	R-386, MR-4b
Pulsation Dampening	R-17, R-457
Pumps	R-52, R-81, R-127, R-504, R-614
Purification	R-75, R-174, R-184, R-248, R-381, R-606
Refrigeration	R-61, R-65, R-153, R-154, R-169, R-210, R-221, R-257, R-283, R-323, R-345, R-355, R-393, R-421, R-432, R-452, R-471, R-477, R-511, R-540, R-552, R-599, R-629, R-647, R-657, R-682
Safety	MR-3, R-708
Seals	R-176, R-180, R-203, R-255, R-320, R-325, R-329, R-436, MR-9
Slush or Solid-Liquid Mixtures	R-394, R-404, R-467, R-489, R-509, R-579, R-580, R-613
Space Venting	R-281
Stainless Steel Properties	R-186, R-206, R-234, R-352, R-401
Strain Gauge	R-51, R-131, R-225
Stratification	R-148, R-156, R-359, R-700
Superconductivity	R-178, R-190, R-231, R-272, R-277, R-289, R-324, R-328, R-333, R-342, R-379, R-383, R-385, R-430, R-441, R-472, R-491, R-517, R-543, R-544, R-545, R-554, R-558, R-602, R-603, R-620, R-621, R-622, R-623, R-627, R-639, R-660, R-662, R-665, R-679, R-684, R-688, R-691, R-694, R-715
Thermal Conductivity	R-27, R-32, R-40, R-50, R-67, R-68, R-88, R-161, R-250, R-294, R-307, R-484, R-610, R-641, R-642, R-653, R-664, R-697, R-702
Thermal Expansion	R-191, R-237, R-483
Thermal Insulation	R-24, R-49, R-58, R-110, R-123, R-133, R-138, R-141, R-142, R-143, R-193, R-240, R-253, R-294, R-373, R-530, MR-2, R-672
Thermocouples	R-83, R-102, R-103, R-161, R-170, R-188, R-208, R-258, R-427, R-444, R-488, R-534, MR-13, R-644, R-639, R-696, R-706, R-713
Thermodynamic Properties	R-222, R-243, R-293, R-295, R-299, R-301, R-322, R-380, R-415, R-417, R-418, R-460, MR-18, R-646, R-707
Thermometry	R-37, R-82, R-167, R-171, R-185, R-233, R-259, R-266, R-376, R-377, R-428, R-448, R-466, R-500, R-549, R-635, R-652, R-680
Transfer Lines	R-11, R-12, R-48, R-53, R-55, R-62, R-140, R-157, R-164, R-166, R-287, R-296, R-374, R-438, R-469
Transition Joints	R-10
Transport Properties	R-391, R-397, R-410, R-420, R-445, R-449, R-454, R-456, R-481, R-497, R-519, R-520, R-581, R-582, R-594, R-661, R-668, R-703
Transportation	R-121, R-130
Vacuum Technology	R-344, R-539
Valves	R-14, R-33, R-92, R-433, R-501

Vapor Pressure

R-125, R-172, R-538, R-568

Vibration Testing

R-29

Index

NBS Technical Notes, NBS Monographs, NBS Special Publications, NBS Circulars, etc.

<u>Tech. Note No.</u>	<u>R or MR No.</u>	<u>Title and Authors</u>
4	R-125	The vapor pressures of some hydrocarbons in the liquid and solid state at low temperatures, by W. T. Ziegler.
8	R-126	Thermodynamic properties of helium at low temperatures and high pressures, by D. B. Mann and R. B. Stewart.
38	R-153	Design and construction of a liquid hydrogen temperature refrigeration system, by D. B. Chelton, J. W. Dean and B. W. Birmingham.
39	R-154	Helium refrigeration and liquefaction using a liquid hydrogen refrigerator for precooling, by D. B. Chelton, J. W. Dean, T. R. Strobridge, B. W. Birmingham and D. B. Mann.
56	R-165	A bibliography of the physical equilibria and related properties of some cryogenic systems, by T. M. Flynn.
108	R-197	A compilation of the physical equilibria and related properties of the hydrogen-carbon monoxide system, by D. E. Drayer and T. M. Flynn.
109	R-196	A compilation of the physical equilibria and related properties of the hydrogen-helium system, by D. E. Drayer and T. M. Flynn.
110	R-195	A compilation of the physical equilibria and related properties of the hydrogen-nitrogen system, by D. E. Drayer and T. M. Flynn.
115	R-211	Load carrying capacity of gas-lubricated bearings with inherent orifice compensation using nitrogen and helium gas, by H. Sixsmith, W. A. Wilson and B. W. Birmingham.
120	R-217	A tabulation of the thermodynamic properties of normal hydrogen from low temperatures to 300°K and from 1 to 100 atmospheres, by J. W. Dean.
120A	R-235	A tabulation of the thermodynamic properties of normal hydrogen from low temperatures to 540°R and from 10 to 1500 psia, Supplement A (British Units), by J. W. Dean.
122	R-219	A survey of the literature on heat transfer from solid surfaces to cryogenic fluids, by R. J. Richards, W. G. Steward and R. B. Jacobs.
129	R-218	The thermodynamic properties of nitrogen from 64 to 300°K between 0.1 and 200 atmospheres, by T. R. Strobridge.
129A	R-268	The thermodynamic properties of nitrogen from 114 to 540°R between 1.0 and 3000 psia, Supplement A (British Units), by T. R. Strobridge.
130	R-220	Provisional thermodynamic functions for para-hydrogen, by H. M. Roder and R. D. Goodwin.
137	R-230	A bibliography of the thermophysical properties of oxygen at low temperatures, by J. G. Hust, L. D. Wallace, J. A. Crim, L. A. Hall and R. B. Stewart.
144	R-232	Dielectric constant of liquid parahydrogen, by R. J. Corruccini.
147	R-233	Cryogenic temperature measurement with platinum resistance thermometers— is fixed-point calibration adequate?, by R. J. Corruccini.
154	R-242	The thermodynamic properties of helium from 3 to 300°K between 0.5 and 100 atmospheres, by D. B. Mann.
154A	R-264	The thermodynamic properties of helium from 6 to 540°R between 10 and 1500 psia, by D. B. Mann.
179	R-297	Choking two-phase flow literature summary and idealized design solutions for hydrogen, nitrogen, oxygen, and refrigerants 12 and 11, by R. V. Smith.
183	R-299	A comparison of two melting-pressure equations constrained to the triple point using data for eleven gases and three metals, by R. D. Goodwin and L. A. Weber.
200	R-300	Carbon resistors for cryogenic liquid level measurement, by R. C. Muhlenhaupt and P. Smelser.
202	R-306	Thermodynamic property values for gaseous and liquid carbon monoxide from 70 to 300°K with pressures to 300 atmospheres, by J. G. Hust and R. B. Stewart.
217	R-327	A bibliography of thermophysical properties of argon from 0 to 300°K, by L. A. Hall, J. G. Hust, and A. L. Gosman.
218	R-332	The electrical properties of aluminum for cryogenic electromagnets, by R. J. Corruccini.

<u>Tech. Note No.</u>	<u>R or MR No.</u>	<u>Title and Authors</u>
227	R-345	The Joule-Thomson process in cryogenic refrigeration systems, by J. W. Dean and D. B. Mann.
301	MR-19	On the formulation and numerical evaluation of a set of two-phase flow equations modelling the cooldown process, by S. Jarvis, Jr.
309	R-347	A bibliography of experimental saturation properties of the cryogenic fluids, by N. A. Oliin and L. A. Hall.
314	MR-21	Stability of two-phase annular flow in a verticle pipe, by S. Jarvis, Jr.
316	R-358	Solubility of solids in dense gases, by J. M. Prausnitz.
317	R-368	Boiling heat transfer for oxygen, nitrogen, hydrogen, and helium, by E. G. Brentari, P. J. Giarratano and R. V. Smith.
321	R-366	Spark planing damage in copper, by J. J. Gniewek, A. F. Clark and J. C. Moulder.
322	R-365	Surface tensions of normal and para hydrogen, by R. J. Corruccini.
323	R-367	Refractive index and dispersion of liquid hydrogen, by R. J. Corruccini.
333	R-389	The viscosity and thermal conductivity coefficients of dilute argon between 100 and 2000°K, by H. J. M. Hanley.
343	R-399	Temperature-entropy diagram for parahydrogen triple-point region, by C. F. Sindt and D. B. Mann.
348	R-409	Infrared reflectances of metals at cryogenic temperatures - a compilation from the literature, by P. F. Dickson and M. C. Jones.
350	R-410	The viscosity and thermal conductivity coefficients of dilute nitrogen and oxygen, by G. E. Childs and H. J. M. Hanley.
352	R-420	The viscosity and thermal conductivity coefficients of dilute neon, krypton, and xenon, by H. J. M. Hanley and G. E. Childs.
354	R-432	The single-engine Claude cycle as a 4.2°K refrigerator, by R. C. Muhlenhaupt and T. R. Strobridge.
355	R-433	Correlations for predicting leakage through closed valves, by J. Hord.
356	R-435	Comparison of incompressible flow and isothermal compressible flow formulae, by J. Hord.
359	R-451	Two-Phase (liquid-vapor), mass-limiting flow with hydrogen and nitrogen, by J. A. Brennan, D. K. Edmonds and R. V. Smith.
360	R-453	On the selection of the intermolecular potential function: Application of statistical mechanical theory to experiment, by H. J. M. Hanley and M. Klein.
361	R-460	Saturated liquid densities of oxygen, nitrogen, argon, and parahydrogen, by H. M. Roder, R. D. McCarty and V. J. Johnson.
362	R-452	Thermodynamic properties of He ³ -He ⁴ solutions with applications to the He ³ -He ⁴ dilution Refrigerator, by R. Radebaugh.
363	R-457	Computer solutions for thermal-acoustical oscillations in gas-filled tubes, by M. T. Norton and R. C. Muhlenhaupt.
364	R-458	Slush hydrogen pumping characteristics, by D. E. Daney, P. R. Ludtke, D. B. Chelton and C. F. Sindt.
365	R-459	Survey of electrical resistivity measurements on 16 pure metals in the temperature range 0 to 273°K, by L. A. Hall.
365-1	R-596	Survey of electrical resistivity measurements on 8 additional pure metals in the temperature range 0 to 273 K, by L. A. Hall and P. E. E. Germann.
366	R-471	An analysis of the Brayton cycle as a cryogenic refrigerator, by R. C. Muhlenhaupt and T. R. Strobridge.
367	R-461	A bibliography of thermophysical properties of methane from 0 to 300°K, by L. A. Hall.
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Liquefied Natural Gas (LNG) Literature Survey is prepared quarterly for the American Gas Association. The first issue, dated March 1970, contained over 300 references listed under 23 categories. Members of the American Gas Association are eligible to receive a complimentary subscription by requesting it from AGA Headquarters, Attention: Mr. Louis Sarkes. Non-members may order a subscription from National Technical Information Service, Springfield, Va. 22151. The price is \$20 per year.

A Superconducting Devices and Materials Literature Survey is prepared quarterly in cooperation with the Office of Naval Research. The March 1972 issue included 318 references indexed under 39 subject headings. Subsequent issues will be somewhat comparable in size. A capsule review of some of the more important papers in each issue was added in 1969. This feature is written by Dr. Robert A. Kamper of NBS. A subscription may be ordered from National Technical Information Service, Springfield, Va. 22151. Price is \$20 per year.

Thermodynamic and Transport Properties Data for cryogenic fluids and selected solids can be obtained from Mr. Hans M. Roder, Project Leader for the Data Compilation Group. His telephone number is (303) 499-1000, Ext. 3528. The descriptive list on page 74 shows the computer programs which are available. These computer programs are written in FORTRAN IV language and are currently operational on a CDC 3800 computer. The programs are available at a cost of \$50.00 per program which includes a card deck and a sample run on our computer. Inquiries should be addressed to Mr. R. D. McCarty, National Bureau of Standards, Cryogenic Data Center, Boulder, Colorado 80302. Mr. McCarty's telephone number is (303) 499-1000, Ext. 3386.

Local Use of the Data Center. Visitors are invited to use the Center's library, world literature file, catalog and abstract files, microfilm facilities, etc., whenever it is convenient for them to do so. The staff of both the Data Compilation and the Documentation units are happy to help with answers to questions, to aid with hard-to-find type of literature, or to offer advice as to best sources of information.

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Fluid	Document	Program Name	Program		Range		Input	Output
			Type	Acy	P	T		
Ar	NBS-NRDS 27	AR PROPS	BWR, 16	1	1000 atm	TP-300 K	P-T, ρ -T	P, ρ, T, S, H, U
CO	NBS TN 202	CO PROPS	BWR, 16	1	400 atm	70-300 K	P-T, ρ -T	P, ρ, T, S, H, U
D ₂	NBS Report- Unpublished	D ₂	BWR, 24	1	400 atm	TP-300 K	P-T, ρ -T	P, ρ, T, S, H, U
F ₂	NBS TN 392	SAMPLE, PVT F ₂	Poly Int	1	24 MN/m ²	TP-300 K	P-T	$P, \rho, T, S, H, U, C_p, C_v, \left(\frac{\partial P}{\partial T}\right)_\rho, \left(\frac{\partial P}{\partial T}\right)_\rho, \left(\frac{\partial P}{\partial T}\right)_T, W$
	No reference	Never issued	BWR, 24	2	240 atm	TP-300 K	P-T, ρ -T	P, ρ, T, S, H, U
He	NBS TN 631	HE PROPS (71)	BWR, 87	1	1000 atm	LP-1500 K	P-T, ρ -T	$P, \rho, T, S, H, U, C_p, C_v, \eta, \lambda$ and others
	NBS Report- Unpublished	HE PROPS (70)	BWR, 35	2	1000 atm	LP-1500 K	P-T, ρ -T	$P, \rho, T, S, H, U, C_p, C_v, \left(\frac{\partial P}{\partial T}\right)_\rho, \left(\frac{\partial P}{\partial T}\right)_T, W$
	NBS TN 154	HE PROPS (62)	BWR, 17	3	100 atm	3-300 K	P-T, ρ -T	P, ρ, T, S, H, U
H ₂	NBS Mono 94	THERMO or VALUES	Poly Int	1	340 atm	TP-100 K	P-T	$P, \rho, T, S, H, U, C_p, C_v, \left(\frac{\partial P}{\partial T}\right)_\rho, \left(\frac{\partial P}{\partial T}\right)_T, W$
	NBS TN 130	PROP TRS and PROP LIQ	BWR, 16	2	340 atm	33-300 K	P-T, ρ -T	P, ρ, T, S, H, U
	In Preparation	H2HIP	BWR, 16	2	340 atm	TP-32 K	P-T, ρ -T	$P, \rho, T, S, H, U, C_p, C_v, W, \eta, K$
(Para)/(Equi)	NBS TN 625	TAB CODE	Lin Int	3	700 atm	TP-700 K	P-T, ρ -T	$P, \rho, T, S, H, U, C_p, C_v, K, \eta, W$
Para	NBS TN 617	H ₂ PROPS	BWR, 17	1	5000 psi	TP-6000 R	P-T, P-H	(all of above plus, $\theta, \delta, \beta, Pr, \alpha, \nu$
CH ₄	NBS Report In Preparation	METHERM 4	Non-Ana	1	10,000 psi	TP-180 R	P-T	(and others
Ne	ASME Advances 65 R-346	NE PROPS	BWR, 18	1	200 atm	TP-500 K	P-T	$P, \rho, T, S, H, U, C_p, C_v, \left(\frac{\partial P}{\partial T}\right)_\rho, \left(\frac{\partial P}{\partial T}\right)_T, W$
N ₂	NBS TN - In Preparation	N ₂ PROPS	BWR, 32	1	10,000 atm	25-300 K	P-T, ρ -T	P, ρ, T, S, H, U
O ₂	Stewart, J. Res. 70, R-559	O ₂ PROPS PVT 02	BWR, 32	2	340 atm	64-1900 K	P-T, ρ -T	Same as H ₂ , O ₂ and He
	NBS TN 384	PVT 02 & TEST	Poly Int	1	5000 psi	65-300 K	P-T, ρ -T	$P, \rho, T, S, H, U, C_p, C_v, W$
			Poly Int	1	340 atm	TP-300 K	P-T	$P, \rho, T, S, H, U, C_p, C_v, \left(\frac{\partial P}{\partial T}\right)_\rho, \left(\frac{\partial P}{\partial T}\right)_T, W$
			Poly Int	1	5000 psi	TP-600 R	P-T	(all of above & $\theta, \delta, \beta, Pr, \alpha, \nu, K, \eta$ (and others

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After an individual user makes a spot check of his own thermocouple with its junctions at known temperatures, a computer program is used to compare the results of the spot calibration with an NBS calibration table. The computer then calculates a correction factor and generates a "working" table tailored to the particular thermocouple. The table may be obtained in °C or °K, with any reference temperature within the range of the table. Tables can be generated for most of the commercial, low-temperature, thermocouple materials.

This program is compatible with many types of computers, making possible the use of local computers. The NBS Cryogenic Data Center will furnish, at cost, the materials and instructions necessary for the user to develop his own tables. The materials needed are (1) a thermocouple data deck, and (2) a program deck, written in FORTRAN II, IV, or 3600, which was developed to adjust the "standard" data to fit a particular thermocouple.

It is preferred that the customer use a local computer. If, however, one is not available, the Cryogenic Data Center will process the spot calibration data furnished by the user. For further information, contact L. L. Sparks, National Bureau of Standards, Cryogenics Division, 275.02, Boulder, Colorado 80302 (Phone (303) 499-1000, Extension 3612).

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